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HEALTH HAZARDS IN THE INDUSTRIES OF NIAGARA FALLS, N. Y.

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Before describing the hazards to the health of the workers in the industries of Niagara Falls, N. Y., it may be well to discuss briefly some of the matters which are preliminary to this field investigation.

The investigation was prompted by a letter dated June 27, 1918, to the Commissioner of Labor Statistics, United States Department of Labor, in which the secretary of the employers' association of Niagara Falls asked permission of the Federal Government to introduce women into "shift work." If women were employed it would mean their working between the hours of 10 p. m. and 6 a. m., a thing specifically prohibited by the New York State labor law. Inability to get sufficient male labor to fill the vitally essential production assignments of the Army and Navy was the reason given for the request.

This request brought a problem of many angles. It called for a determination as to whether conditions in the community warranted the temporary setting aside of the State law prohibiting night work among women, or whether the solution of this production problem lay in other measures.

The Commissioner of Labor Statistics referred the request to the newly created "Woman in Industry Service" of the Department of Labor. This service in its report entitled "Proposed employment of women during the war in the industries of Niagara Falls, N. Y.," stated that "because of the multiplicity of the problems involved, the Woman in Industry Service decided to associate with it in this work other Federal agencies vitally interested in the industries there, not only because they were essential in themselves, but because they illustrated a problem of man power and the proposed introduction of women in many other industries of the country. To deal with those aspects of the problem, which center primarily in conditions affecting the health of the workers, the committee on hazardous occupations was formed, with a membership represent-

ing Federal agencies concerned with women in industry and with the health of the civilian population, the Department of Labor in the State affected, and the Federal departments having a direct or indirect interest in contracts in the chemical industries."

The committee on hazardous occupations decided that in order to deal intelligently with that side of the problem which is concerned with conditions affecting the health of the workers, a field investigation was necessary. Miss Mary Van Kleeck, director of the Woman in Industry Service, Passed Asst. Surg. A. J. Lanza, United States Public Health Service, and Capt. A. D. Reily, Ordnance Department, were named on a subcommittee to supervise the field work. A field staff was detailed to Niagara Falls by the Public Health Service to study and report upon (1) the hygiene and sanitation in the plants, making recommendations for correcting faulty conditions, and (2) the extent to which women might be employed if war conditions should necessitate their going into the plants in increasing numbers.

The consultant staff, composed of Dr. Alice Hamilton, United States Bureau of Labor Statistics; Prof. C.-E. A. Winslow, Dr. David Edsall, and Dr. W. Gilman Thompson, United States Public Health Service, met with the field staff at frequent and regular intervals throughout the investigation.

The Woman in Industry Service has prepared a report, "Proposed Employment of Women During the War in Industries of Niagara Falls," which analyzes the labor problem and answers the question of the employers' association as to the employment of women in the industries of that community. The report which follows, on the other hand, is a summary of the field workers' findings on the hygiene and sanitation in the individual plants.

METHOD AND EXTENT OF THE INQUIRY.

The plant inspectors were picked because of their ability to recognize the industrial health hazards and to make practicable workable recommendations for their removal. Most of them had been making occupational disease investigations for the Public Health Service for some months and in numerous industries in different parts of the United States. The field staff, exclusive of the supervisor, consisted of the following members:

C. G. Augustus, M. D.
Gordon E. P. Wright, sanitary engineer.
M. D. Shie, M. D.
F. D. Metcalf, M. D.
Wm. M. Goehring, M. D.
Roy Welter, sanitary inspector.

Leonard Greenburg, chemical engineer.
David Greenberg, chemical engineer.
H. P. Gale, mechanical engineer.
E. N. Riley,[1] safety engineer.

The investigators worked in pairs on the group of plants with which their previous experience had made them familiar. However, specialists on the staff were assigned wherever their help was needed to solve some special problem. Such assignments were especially required, for instance, in the case of the mechanical engineers, as problems of dust, gas, and fume removal were exceedingly numerous.

In a report of this kind it is impossible to give in full the outline followed in making the inspections and in writing the reports on the individual plants. Stating it briefly, the detailed written reports cover the following points for each department and process of each plant: The nature and construction of the buildings; the ventilation, humidity, dust, fumes, gases, illumination, infection hazards, specific poisons, extremes of heat or cold, noises, and odors; the personal service facilities, such as toilet, washroom, locker, eating, drinking, and rest-room accommodations; the medical and surgical care of employees, including physical examinations and first-aid practice; hours of work, fatigue, absenteeism, and labor turnover; transportation facilities to and from work; and the educational measures used to prevent occupational ailments among workers. The individual plant reports, covering the above points and containing detailed and specific recommendations for removing health hazards, were sent to the respective plant executives.

The field force began work August 10, 1918, and finished September 10, 1918. This was the time allotted for the survey. It was not the purpose to delve deeply into any one phase of the health problems, the idea being to get the facts concerning hygienic conditions quickly and at the same time to get practical results in the way of improving working conditions for both men and women workers.

Except for the physical examinations of the employees in the picric department of one plant, undertaken at the request of the management, no examinations of the workers were made. In only a few instances were workers questioned, as it was the policy of the investigators not to do anything that would in the least interfere with production.

The 21 plants represented in the employers' association were investigated. With the exception of a few plants, this membership includes all the industrial establishments in Niagara Falls. These

[1] Mr. Riley was detailed from the Ordnance Department to the Public Health Service. The others of the staff are scientific assistants in the Public Health Service.

21 plants, grouped according to the products they manufacture, are as follows:

TABLE I.—*The number of employees for each group.*

Products manufactured.	Number of plants.	Number employed.		
		Men.	Women.	Total.
Abrasives	3	1,734	490	2,224
Chemicals and gases	8	2,242	8	2,250
Electrodes and carbon	3	1,230	19	1,249
Metals and alloys	4	2,667	33	2,700
Miscellaneous	3	650	132	782
Total	21	8,523	682	9,205

INDUSTRIAL HYGIENE OF THE PLANTS BY GROUPS.

Abrasives.

The abrasives made in Niagara Falls when made into grinding wheels, dental drills, razor hones, abrasive paper, whetstones, etc., are known throughout the world by a variety of trade names, the most common of which are carborundum, corundum, crystolen, aloxite, alundum, etc. These products are used extensively in the manufacture of steel, iron, brass, and copper articles.

Dust the chief hazard.—The manufacture of these products is attended with some marked hazards to the health of the workers, the most important of which is dust. This hazard, in the opinion of the writer, is by far the most serious of any of the industrial health hazards in Niagara Falls.

Other health hazards are more spectacular because they produce visible effects quickly. Dust from abrasive materials does not render a worker unconscious, or cause him visible distress, but accomplishes its harmful effects without unduly alarming or exciting any one.

The three plants investigated cover the entire industry in Niagara Falls; two manufacture crude abrasive material, which is shipped to other places to be made into commercial articles; the third makes both the crude material and the finished product. They employ 2,224 persons, of whom 1,734 are men and 490 are women. The one plant making the finished commercial products employs 470 women, while the remaining 20 women are employed in one of the other plants. All are exposed to dust in varying amounts; not even the office force escapes.

TABLE II.—*Nationalities of the workers of the three plants manufacturing abrasive materials.*

	Per cent.
American	44
Italian	16
Polish	15
Austrian	9
Spanish	4
Miscellaneous	12

Dust conditions in two of the plants were studied in detail by Leonard Greenburg and David Greenberg. These studies were supervised by Prof. C.-E. A. Winslow of Yale University.[1] The Palmer water-spray method of dust collection was used. The samples were analyzed both microscopically and gravimetrically. Only particles 10 microns and under were counted, as it has been definitely shown [2] that only particles of those dimensions readily gain access to the lungs. The amount of dust by weight in a definite volume of air (100 liters) was also determined in order to use the results as a basis for comparison with other investigations. Dr. Lanza, in his study of dust conditions in the mines at Joplin, Mo.,[3] set a standard of 1 milligram of dust per 100 liters of air as a maximum amount of dust of this character that air should contain. The following tables show the results of these dust counts and weight determination in different working planes and in a variety of processes. In all instances the samples were taken at the breathing level and as close to the worker as possible. In Table III the samples were taken in a lathe room where the wheels are ground and finished for the market.

TABLE III.—*Dust content of air in a lathe room.*

Sample No.	Sampling position.	Total number of particles, 10 microns and under, per cubic foot of air.	Weight of dust, milligrams per 100 liters of air.
8141	Edging machine	1,400,000	3.9
8142	do	2,091,000	8.1
8143	do	7,415,000	22.6
8144	do	2,870,000	18.0
8145	Facing machine	5,950,000	35.0
8146	do	17,200,000	144.6
8131	Center of lathe room	2,724,000	20.1
8132	North end of lathe room	3,635,000	16.9
8133	South end of lathe room	2,134,000	13.4

Ten samples were analyzed in another lathe room and the results are a repetition of those shown in the above table. In their report on this plant Leonard Greenburg and David Greenberg calculate

[1] Public Health Reports, vol. 34, No. 22, pp. 1171–1187.
[2] Report of South African Miners' Phthisis Prevention Commission.
[3] Bulletin 132, U. S. Bureau of Mines.

that a worker where sample No. 8146 was taken would breathe 144.6 milligrams of abrasive dust every 12 minutes.

In Table IV the samples were taken in a shaving room, where the wheels are cut to the required dimensions before being sent to the baking kiln. The dust hazard is greater here than in any of the other processes investigated. These figures show that the dust removal apparatus at that time was inadequate.

TABLE IV.—*Dust content of air in a shaving room.*

Sample No.	Sampling position.	Number of particles, 10 microns and less, per cubic foot of air.	Weight of dust, milligrams per 100 liters of air.
8191	Shaving machine	72,100,000	62.5
8192	do	181,000,000	233.5
8193	Facing machine	15,900,000	12.7
8194	do	15,950,000	16.6
8195	Shaving machine	176,500,000	140.1
8196	do	222,500,000	193.3

Table V shows the results of analysis in the grinding rooms. The crude abrasive, after being removed from the furnaces, is crushed and ground in the rooms where these samples were taken. Samples 8222 and 8226 were taken in the outdoor air near to these grinding rooms. Both analyses show a gross pollution of the outdoor air.

TABLE V.—*Dust content of air in the grinding room.*

Sample No.	Sampling position.	Number of particles, 10 microns and less, per cubic foot of air.	Weight of dust, milligrams, per 100 liters of air.
8213	Pan mill	584,000	.....
8221	do	3,200,000	21.9
8222	Outdoors (gateway)	5,190,000	32.5
8223	Pan mill	8,230,000	37.0
8224	do	10,100,000	33.5
8225	Elevator	32,500,000	115.4
8226	Outdoors (yard)	2,915,000	8.4

In Table VI are found some interesting figures on the dust hazard in the plant offices and laboratories. These samples were taken when the office windows and doors at the plants were closed to minimize dust pollution of the office atmosphere. As a basis for comparison a sample was taken in the Public Health Service office in the Gluck Building, located in the center of the town. It is noted from this table that the lowest count obtained at the plant is nearly twice that obtained in the Gluck Building, and the lowest weight at the plant was four times that obtained in the Gluck Building.

TABLE VI.—*Dust content of air in the plant offices and laboratories.*

Sample No.	Sampling position.	Number of particles, 10 microns and less, per cubic foot of air.	Weight of dust, milligrams per 100 liters of air.
8281	Research laboratory	270,200	2.1
8282	Works office	114,800	1.4
8283	....do	195,000	0.9
8284	Accounting office	651,000	1.0
8285	Billing department	579,000	1.1
9061	Gluck Building	74,200	0.2

These figures show, in a striking way, what the dust conditions are in the abrasive industry. In all the plants surveyed, the air was grossly polluted with dust.

Characteristics of abrasive dust.—The dust particles are very hard, being second only to the diamond in this quality; they are insoluble in ordinary acids or fluids, and are from 95 to 100 per cent inorganic material. Photomicrographs of samples show the particles to be exceedingly jagged and sharp.

Effect on lung tissue.—With the above characteristics in mind, it is easily understood why working in a polluted atmosphere should injure the delicate lung membranes, producing respiratory affections of various kinds and acting in a contributory manner to the onset of other diseases not directly due to dust inhalation. This dust is not eliminated from the lungs, but once it is inhaled it stays in the lungs without a chance of removal by coughing or through the lymphatic system. The effects of the inhalation of this type of dust appear slowly and take a comparatively long time to develop (one to five years). The main reason why ill effects were not observed to a marked extent among abrasive workers in Niagara Falls is that the labor turnover was so large that hardly any workers in the very dusty processes stayed long enough to acquire serious damage to their lungs.

What was done about it? The ordinary facilities for ventilation, such as windows, skylights, and deflectors, were considered adequate in all the plants; but the mechanical devices such as air-exhaust lines for the removal of dusts, gases, and fumes, were not considered adequate in any instance. This is especially true of the dusty processes. A great many dust-producing machines were not equipped with mechanical means for removing the dust. The problem then was one of mechanics, the designing of an efficient hooding and exhaust system. Messrs. Riley and Gale, engineers of the staff, working with the plant engineers, designed two types of hoods which, after several trials and changes, appear efficient. These hoods are to be installed throughout one plant, along with added facilities for increasing the

velocity of the exhaust air. Certain changes and improvements are to be carried out in the two other plants which should materially reduce the dust hazard.

Other hazards.—In the furnace rooms there is exposure to extreme heat and to carbon monoxide and carbon dioxide. In none of the plants were provisions made to protect the workers from the heat or glare. A relatively small number of workers have been "gassed" by CO or CO_2, owing to the large cubic area for diffusion afforded in these rooms.

Chemicals and Gases.

The eight plants investigated in the group manufacturing chemicals and gasses embrace the industry in Niagara Falls, with the exception of one plant manufacturing phosphorus and its compounds. A cursory inspection of the latter plant was made by the writer, who found that these compounds were well handled with respect to exposure to poisoning, and that excellent medical and dental supervision was in force.

Employment of women.—The proportion of women employed in this industry is very small—of the total number 2,250, only 60 are females. The relative proportion of nationalities of these workers is practically the same as that found in the metals and alloys group shown on page 11. These women were found doing a variety of jobs, such as general yard work, cleaning, shoveling, loading and unloading freight cars, laboratory work, etc. None of them, excepting the laboratory workers, held positions requiring skill or training, nor were they unduly exposed to the chemical hazards.

The hazards to the health of these unskilled female workers (nearly all of whom are foreign born) were chiefly the lifting and carrying of heavy weights, exposure to weather conditions, and constant standing. A tendency to "take it easy" was observed, which lessened, to a marked degree, the above mentioned hazards.

The products—Ninety per cent of the following products were for war purposes:

Chlorine.	Picric acid.
Liquid chlorine.	Formaldehyde.
Bleaching powder.	Potassium chloride.
Hydrochloric acid.	Sodium bichromate.
Sulphur chloride.	Carbon tetrachloride.
Chlorobenzel.	Tetrachlorethane.
Chlorobenzol.	Sodium peroxide.
Caustic soda.	Chloroform.

The hazards.—The findings of our investigators are in close accord with those of the New York State Factory Investigating Commission. This commission made a very thorough study of the industrial

hygiene of the chemical plants in Niagara Falls in 1912, the results of which may be found on page 459, Volume II, of their 1913 report. Inasmuch as the hazards are set forth in detail in that report and the conditions mentioned are, to a large extent, operative, it is not intended to give a detailed description of faulty hygienic conditions here.

Fumes and gases.—Chlorine gas is a source of great annoyance, not only in the plants but in the community. It is suffocating in effect, and in minute quantities it produces coughing and choking in persons not accustomed to it. Older workers seem to develop an immunity to moderate amounts. Chlorine is very noticeable in the center of the town when the wind is from the direction in which the plants are located. There are very few cases of chlorine "gassing" because the workers know of the hazard and take to their heels when a leak or "break" develops. No two of the plants make chlorine by the same process, and in only one place is the cell room chlorine-free at all times. In only one instance were conditions "poor"; this hazard was only periodically present in the remaining plants. The remedy lies in strict mechanical supervision of the apparatus to prevent leaks or breaks, or in the use of a process of a demonstrated efficiency in keeping chlorine out of the breathing atmosphere.

Workers in the "bleach chambers," where the lime is chlorinated, are periodically exposed to large amounts of gas. The men work in 20 to 30 minute shifts every 2 to 3 hours. When fully dressed they resemble arctic explorers; only their eyes, goggle covered, are visible. A many-layered cloth respirator is used. A mechanical device of undoubted efficiency for chlorinating lime has been designed, and if it could be used it would obviate these needless exposures.

Hydrogen gas and caustic fumes were encountered in two plants, with a comparatively small number of workers exposed.

Nitrous oxide and benzol fumes were noted in one plant and were producing slight symptoms in the small number of workers exposed. Improvements were being made during the inspection to correct the condition.

Tetrachlorethane was manufactured experimentally on a small scale in one plant, with little hazard to the few workers employed.

Formaldehyde was a slight hazard in one plant.

Dusts.—The dusts encountered in the chemical industry produce visible effects on the skin and the mucus membranes of the upper respiratory tract. They are irritants and poisons, doing actual damage to the membranes with which they come in contact. Bleaching powder dust ($CaOCl_2$) constituted a serious hazard in all but one of the plants inspected. The chief exposure is in filling the cans from the "bleach chambers." The powder is dropped through a hole in

the chamber floor to the can directly beneath. This operation produces a dusty condition, due to the lack of an inclosed chute connecting the floor with the top of the can. In one instance a metal chute was provided which rendered the process dust free. Canvas protectors were used in several plants, but with little success, as the workers were compelled to wear cloth respirators.

The handling of lime is dusty, and very few plants were using mechanical devices. Sodium hydroxide dust constituted a hazard of importance in a number of the processes.

The "sores," particularly those in the nasal septum, produced by potassium bichromate, were in evidence in a few instances among workers exposed to this hazard. The men, without exception, had their noses stopped with cotton as a preventive measure.

Soda ash and chrome ore dusts were noted as a hazard in one plant. Chlorinated sulphur or sulphur chloride, the basic material in "mustard gas," constituted a slight hazard in one other plant. It must be borne in mind that the workers learn by experience to exercise some degree of caution in handling chemicals; the element of warning is present in that visible evidence is often produced showing the results of carelessness and ignorance.

Caustic burns.—In all plants producing caustic potash (NaOH) a marked laxity and carelessness in handling molten caustic was noticed. Workers did not wear goggles, but gloves were worn generally. Plant officials were urged to see that goggles were worn, and that caustic pots and drain troughs were guarded by railing, covers, etc., to prevent accidents.

Electrodes and Carbon Compounds.

The three plants producing carbon electrodes, graphitized electrodes, graphite, and carbon compounds (chiefly lubricants), covered in the inquiry, employ 1,249 persons, only 19 of whom are females. Approximately 46 per cent were Polish, 20 per cent American, and all other nationalities, 34 per cent.

The 19 women were employed mainly at cleaning electrodes, yard work, shoveling, and as janitors. None was unduly exposed to hazards.

The dust produced in this industry is objectionable mainly because it is a "dirty" dust. It is black, exceedingly fine and fluffy. Because it gives everything a black coating, including the workers, and absorbs light, the plants have a dark and gloomy appearance.

Two of the plants had fairly efficient dust-removal systems; the third has installed a complete new system since our survey was made. The results are good in that very little dust escapes into the workrooms.

From a health standpoint this amorphous dust is in no way comparable, as far as detrimental effects to the respiratory system are concerned, to the abrasive dusts mentioned elsewhere in this report. While this dust causes little or no mechanical injury to the lungs, yet constant exposure predisposes, in later life, to bronchial and pneumonic illnesses.

Furnace gases, which are mainly CO and CO_2, constituted a rather serious hazard in one plant. Here again, an exhaust system has been installed.

Heat.—Heat from the furnaces was an objectionable feature in two plants. No means for mitigation of this hazard were used.

Metals and Alloys.

The four plants investigated cover the industry of metals and alloys in Niagara Falls with the exception of three furnace rooms in one establishment.

The total number of employees was 2,700, of which 2,667 are males and 33 females. By nationalities, Americans constituted 29 per cent; Italian, 22; Polish, 12; Hungarian, 5; and unknown, 32 per cent.

The products of this industry are ferroalloys, chrome metals, alloys of chrome, alloys of tungsten, manganese and its alloys, titanium alloys, and aluminum sheet metal.

Excessive heat, furnace gases, and dusts.—In none of the plants in the other groups are such large numbers of workers exposed to high temperatures as in this electrothermal industry. The heat given off from the electric furnaces varies from 100° F. to 120° F., 10 to 15 feet from the furnaces, and even the hardened workers are at times "laid out" by it. The white-hot radiating surfaces are large, and furnace after furnace throws out its intense heat. In no instance was any provision made to reduce this hazard with water screens, heat chains, fans, or other devices.

In two plants furnace gases, mainly CO and CO_2, were the hazards. Records, in a few instances, of ill effects were obtained. In the other plants this hazard was not present to a marked degree. The large cubic air space available for dilution of these gases probably accounts for the smaller number of "gassing cases" in these furnace rooms.

Phosphene gas was not adequately removed in one plant, with the result that a few of the workers were affected. The symptoms of poisoning were headache, dizziness, nausea, and coma, according to statements made at the plant.

The dusts.—The dusts originated in the shoveling, transporting, grinding and sorting of the various ores containing the desired

metals. The dust particles are hard, angular, and inorganic in composition. The effect on the respiratory tract is therefore injurious. In this respect the dusts are similar to the abrasive dusts described earlier in the report. Dust conditions were bad in a number of the processes. Upon the advice of our engineers, a dust exhaust system was installed in two very dusty departments of one plant.

Miscellaneous.

The three plants in the miscellaneous group were, at the time of the investigation, producing brass, bronze, copper, and aluminum casings, storage batteries, spindle wheels for tanks, electrical equipment for automobiles (chiefly lighting systems), and hand flashlights.

The total number of employees in these plants was 782, of whom 650 were males and 132 females. The nationalities represented were as follows: American, 63 per cent; Italian, 13; Polish, 11; and miscellaneous, 13.

The lead hazard.—The methods of handling lead and its oxides were found to be so crude that a great number of workers were needlessly exposed to this specific systemic poison. Very few of the efficient precautions to prevent lead poisoning were taken. With the causes, nature, symptoms, and methods of prevention of a poisoning as well known as that of lead, it is indeed surprising to find efficient safeguards so utterly ignored.

In one of the three plants the following conditions were found: The molten lead was hand-ladled or run by gravity into the various shaped molds. Twenty-eight pots were hooded, but anemometer readings showed little or no air velocity or suction, and the hoods were classed as completely inadequate; the average distance of the hood from the pot was 23 inches. Two of the 28 hoods had no connection with an exhaust fan, and one lead pot had no hood at all.

The handling of oxides of lead was done carelessly. These oxides are shipped to the plant in barrels, and are mixed by hand-shoveling under a suctionless exhaust hood to form the "batch." Clouds of dust were seen when the oxides were shoveled out of the barrels into the weighing device, and from the weighing boxes into the mixing pots. The "mix" is agitated while an acid is added. The dust is excessive; the floors, even though wet down and swept four to five times daily, are always dusty. After this paste is thoroughly mixed, it is run through a series of rolls and deposited on the floor, whence certain portions are carried by the heels of the workers to various places in the plant. The workers wear cloth respirators and gloves; but have their sleeves rolled up, and their clothing is covered with lead dust. In one department, where storage-battery plates are "pasted," a number of workers were seen without gloves or cloth

respirators; their faces and hands and clothing were smeared with lead paste. The wooden floor of this department had much lead ground into it.

Five girls were discovered in a lead-molding room where the exhaust system was of poor construction and practically functionless; there were 18 pots containing molten lead in this room, and one of the 18 had no hood at all.

Workers in processes having lead as the hazard did not have properly constructed or supervised toilet or washing facilities. A lunch room was provided, but a number of lead workers were seen eating in the toilet and washrooms, the floors of which were spotted with trackings of lead oxide dust.

Lead poisoning.—The investigators, without any systematic effort to discover evidences of lead poisoning among the workers, had brought to their attention several cases of gastric disturbances, one instance of partial "wrist drop," and two workers with distinct blue, or lead line, on the gums. The medical records at the plant showed only two diagnoses of lead poisoning in the five months' period prior to the inquiry. The high labor turnover reduces the incidence of lead poisoning; the turnover in the molding room, for instance, was 60 per cent per month.

Brass poisoning.—The exposure to brass fumes was found to be very pronounced in one foundry room, and a number of the molders admitted having the "ague" or "brass shakes" occasionally. There was absolutely no means for exhausting the fumes; the ceiling of the room was low.

Sulphuric acid fumes.—The breathing atmosphere in the "forming" rooms in one plant contained, in rather concentrated form, the fumes and atomized spray of solutions of sulphuric acid. These fumes are known to have a corroding effect upon the teeth and a very irritating action upon the respiratory mucus membrane.

OTHER INFORMATION ON ALL THE PLANTS.

It will be seen from Table VII that there is only one plant employing a full-time physician. Two plants employ one physician each on part time; the time spent in one plant is five hours daily and three to four hours daily in the other. Eighteen plants call a physician in case of accident, sickness, or any emergency that the regular first-aid agent can not handle. Physical examinations were made in three plants, but not according to any set plan. Employees in the dusty processes of one abrasive plant were examined physically every three months by two first-aid men, neither of whom is a physician. These examinations were supervised by the doctor. In no instance were employees examined before employment, and with the above-mentioned exception, none at regular intervals after employment.

TABLE VII.—*Medical supervision.*

Products manufactured.	Physicians.			Physical examinations.
	Full time.	Part time.	On call for emergencies.	
Abrasives	0	1	2	1
Chemicals and gases	0	0	8	0
Electrodes and carbons	0	0	3	0
Metals and alloys	1	0	3	1
Miscellaneous	0	1	2	1
Total	1	2	18	3

TABLE VIII.—*Dispensary practice.*

Products manufactured.	Central dispensary.	Dressing stations.	Full-time trained attendants.	Foremen, matrons, clerks, etc.
Abrasives	3	0	1	2
Chemicals and gases	6	2	2	6
Electrodes and carbons	3	0	1	2
Metals and alloys	4	0	1	3
Miscellaneous	2	1	1	3

The equipment of these dispensaries ranged from a bottle of iodine, bandages, and cotton, up to the elaborate outfit sufficient to care for major surgical cases. The trained attendants consisted of four trained nurses, distributed over four plants, and two full-time first-aid men in one plant. The dispensary practice in the plants having these trained workers was good; in the establishments where first aid was done by the foremen, matrons, chemists, and such persons, the equipment was, in most instances, insufficient and improperly used.

TABLE IX.—*Personal service facilities.*

	Toilet.	Washing.	Locker.	Eating.	Drinking.	Rest rooms.
Abrasives:						
Good	1	1	2	2	0	1
Fair	1	1	1	0	2	1
Poor	1	1	0	1	1	0
Chemical:						
Good	2	2	2	1	2	0
Fair	2	2	2	1	2	0
Poor	4	4	4	6	4	0
Electrical:						
Good	1	2	0	1	2	0
Fair	1	1	2	1	1	0
Poor	1	0	1	1	0	0
Metals and alloys:						
Good	1	2	1	1	2	0
Fair	3	2	2	3	2	0
Poor	0	0	1	0	0	0
Miscellaneous:						
Good	0	1	0	0	1	0
Fair	1	1	2	2	2	1
Poor	2	1	1	1	0	0

The general average of labor turnover per month in the different industries investigated was as follows:

	Per cent.
Abrasives	25
Chemicals	24
Electrical (1 plant for 4 weeks)	58
Metals and alloys	40
Miscellaneous (1 plant)	53

These figures, while in two instances based on a single plant only, show, however, that the turnover for the five-month period preceding the survey was exceedingly high. It is an interesting and significant fact that one plant in the group manufacturing chemicals, having a grading of "good" with regard to hygienic conditions in the plant, and excellent personal service facilities, had the lowest labor turnover—approximately 12 to 15 per cent per month, while another plant in the same group graded as "poor" had the highest turnover, or 33 per cent per month.

Hours of work.—In the abrasive plants, 75 per cent of the employees worked 10 hours in the daytime, 15 per cent were on shift jobs of 8 hours, and 5 per cent worked from 11 to 13 hours in the day.

Shift work in the chemical establishments is 8 hours, and day work is 9 hours, with one exception (10 hours). About 60 per cent of all employees are on day work, the balance being on three shifts on which the men alternate.

The electrode plants use the 8-hour shift and the 9-hour day, and at these plants 48 per cent were on shift and 52 per cent on the 9 to 10 hour day.

Shift work predominated in the metals and alloy group. Forty per cent of workers were on the 8-hour shift, 20 per cent on 12-hour shift, and the remainder on day work which ran from 9 to 12 hours.

The miscellaneous group were working 15 per cent of the employees on 10 and 12 hour shifts, and 85 per cent on the 9 and 10 hour day work.

RESULTS OF THE SURVEY.

As previously stated, one of the principal reasons for the survey was to get practical results in improved working conditions. During the month of April, 1919, two officers from the Office of Industrial Hygiene and Medicine of the United States Public Health Service, Philadelphia district, were detailed to Niagara Falls to see what action had been taken by the manufacturers, following the receipt of our recommendations. Each plant executive had received a report on plant working conditions with specific recommendations for improvement of plant hygiene and sanitation several months prior to this return visit. Sufficient time had therefore elapsed to permit the carrying out of a major portion of the recommended improvements.

A few of the suggestions were carried out while the survey was in progress, but the majority of the alterations were made after the completion of the primary survey.

The check-up investigation in April showed that industrial conditions had changed considerably from what they were during war time. The problem of the employment of women had automatically disappeared with the substitution of male for female labor. Plant officials who were still employing female labor stated that as fast as the women quit they were replaced by men. One abrasive plant had entirely eliminated women workers, and another plant of the same kind, employing a large number of women, was substituting men as fast as possible. A large chemical plant had released all female employees, while the labor force in practically all the plants had been cut considerably, and a number of departments manufacturing war chemicals had been completely closed. However, all the plants were in operation, and considering the peace time value of the products it appeared to be only a matter of a short period for readjustment when they would all be operating on a capacity basis. Increased peace time production coupled with a scarcity of male labor may again bring on employment of women. The investigators found that the following recommendations had been put into effect:

Abrasive plants.—In the abrasive plants, dust is the main hazard, and a few excerpts from the investigators' reports will show what had been done in improving conditions:

"There have been marked changes and extensions in the dust-collecting system in this plant. In one large room practically every machine has been equipped with a specially designed hood, the lower half of which is permanently fastened in position, and the upper half is hinged to the lower half in such a manner that when open it does not interfere with placing and removing pieces on the machine. The installation of these hoods has made a wonderful change from the former dusty conditions in this room. In two other rooms about half the dust-producing machines are equipped with hoods, but plant engineers expect to have complete equipment within the next six weeks."

This plant is well along in a systematic campaign to equip all dust-producing processes or operations with efficient dust-exhaust systems. It has also employed a man of experience to install and supervise a plant department of health. An experienced woman is employed to superintend the personal relations department for women.

Concerning another abrasive plant the investigator remarks: "There is now on the premises complete equipment for the installation of dust-exhaust systems over the crushing machines and the belt conveyor. All of the old machinery and bucket conveyors have been put in good condition with tightening of conveyors, thus eliminating a large amount of the dust. The company is also installing a 'cyclone' on the top of the building for collecting bauxite and alumina dust from the receiving rooms and conveyors in that portion of the plant."

Another abrasive plant has plans for a new building to be erected shortly; the building now in use will be used for the personal service facilities. Meanwhile, care is being exercised to reduce the dust hazard.

Carbon and electrode plants.—One plant in this group had let the contract for the installation of a complete new exhaust system covering all dusty processes. The dust in a plant of this kind is very valuable. An engineer from the Philadelphia district office spent considerable time experimenting at the plant to determine the most efficient type of dust-recovery apparatus to use. Such apparatus has been installed, thus eliminating a nuisance to surrounding plants caused by the escape of fine dust from a stack.

Another plant expects to install suitable dust-collecting machinery in a new building now under construction. A new personal service building is about completed, in which arrangements are made for toilets, wash rooms, shower baths, locker rooms, etc., and an assembly hall. Common drinking cups are being replaced by bubbling fountains.

In another plant "several of the calciners have been provided with hoods, but without satisfactory results. The entire proposition is now in the hands of an engineer's office in another city."

Chemical and gas plants.—Recommendations were not put into effect in this group in near the proportion that they had been in the other groups. This can be accounted for in part by the peace-time adjustment these plants were undergoing. A number of them were repairing and renovating equipment and putting up new buildings. In other instances, however, managements considered present facilities adequate and did not contemplate changes under present conditions. A part of the recommendations were complied with in almost every instance. Suggestions pertaining to increase of personal service facilities and their upkeep met with encouraging response. Men have been supplied and urged to wear goggles in caustic departments where eye injuries are likely to occur. Gas masks are provided in processes generating poisonous gases or fumes. Gloves and special articles of clothing are supplied in a number of cases. Quite a number of changes were noted, such as stricter mechanical supervision of apparatus to prevent leaks of gas; process vats being covered to prevent escape of gas; one rotary burner equipped with exhaust hood; one new caustic grinding machine installed which is dust tight; one new first aid room in charge of nurse; and similar changes.

Metal and alloy plants.—The investigator writes of one plant: "All titling furnaces are now provided with hoods;" "Most of the spouts in the packing room are hooded;" "A new ventilating system is nearly completed in the grinding room;" and of another plant: "A portable screen, about 3 by 6 feet, made of fine mesh galvanized wire, supported by pipe standard with heavy base, at a height to protect the head and body from dust, flying particles, and heat, is now installed." Better supervision of toilets and installation of new ones was noticed in a few instances.

Miscellaneous.—The following notes were made on a storage-battery plant: "There has been no change in the exhaust system, blowers, or methods of pouring molten lead. * * * The five girls

formerly working in the lead-molding room have been placed in another part of the plant away from the lead. No women are now permitted to work where they would be exposed to lead. * * * Lead oxides are mixed and dumped by mechanical means. * * * Floors in the paste mixing room are kept clean by wet sweeping. All men in this department are furnished gauze respirators and gloves. * * * The plate pasting department has been moved to a room having a cement floor and the room formerly occupied by it has been converted into a lunch, locker, and wash room. Employees are not permitted to eat in the pasting department. * * * Four small rest rooms have been provided for girls."

The recommendations as mentioned for all plants were carried out by plant executives of their own free will. The investigators or those supervising them had no power to enforce a single one of them. For this attitude the employers deserve the utmost credit. As will be noted from the body of the report much remains to be done before conditions are what they should be; however, a beginning has been made which it is hoped will be continued.

CONCLUSIONS AND RECOMMENDATIONS.

Facts concerning hygienic conditions brought out by this survey and that made by the New York Factory Investigating Commission in 1912 show conclusively that vigorous and sustained action by the employers, employees, Federal, State, and city agencies is necessary if working conditions are to be permanently improved.

Industrial health hazards are removable. Removing them in the chemical industries of Niagara Falls is not a simple matter; it means time and prolonged effort; it is an expensive undertaking; many radical changes are necessary, which require engineering skill of the highest order; mechanical devices must be substituted for hand labor; the full-time services of expert industrial hygienists are indispensable, if permanent results are to be obtained. The irritating and poisonous dusts, gases, and fumes, and the excessive heat must be prevented from producing specific or nonspecific occupational diseases; and above all, there must be complete cooperation on the part of all concerned in making these industries healthful places in which to work.

Would it pay to follow out these recommendations? That the hygienic workplace has its economic advantage is evident. There is at present a wave of enthusiasm for the betterment of working conditions sweeping over the country. Reputable firms can no longer afford to ignore the importance of correct environmental conditions for their employees. Anything which reduces the physical and mental efficiency of the worker also reduces the quality and quantity of his product, whether that be shells or statistical tables. The writer was recently called into consultation by a firm who wished to improve hygienic conditions in their plant, because, as one of the

officials stated, "our workers leave us to go to a rival plant because they have better working conditions." In this instance wages were the same in both plants.

In another instance a plant asked for assistance from the Office of Industrial Hygiene and Medicine of the Public Health Service, stating that "while we have complied with the provisions of the State law, yet we wish to go beyond that."

Another wrote: "We wish your help in installing an air-conditioning apparatus, as we feel that bad air conditions in our plant are reducing the efficiency of our workers."

Instances of like nature could be multiplied showing that manufacturers believe that faulty industrial hygiene reduces efficiency, and that they are ready to invest in remedial devices and measures.

In view of the great number and the seriousness of the health hazards in the industries of Niagara Falls, it is imperative that permanent and full-time supervision of the physical condition of the workers and the work places be instituted. This, in the opinion of the writer, can be best accomplished by an industrial hygiene unit, located in Niagara Falls.

The following is a tentative outline of the organization and functions of such a unit:

At the head of the unit is the advisory board consisting of two representatives each from the employers, the employees, the medical society, and the chamber of commerce, together with the local health commissioner and the local factory inspector. As executive head and directly under the advisory board comes the director, a physician, preferably trained or experienced in industrial hygiene, and emphatically of executive ability. The director's force should consist of one physician, two industrial nurses, one industrial hygienist (nonmedical), and one mechanical engineer.

The functions of the organization may be briefly set forth as follows:

1. To make physical examinations of the workers engaged in the hazardous occupations;
2. To make plant inspection, to carry on research work, and to make specific recommendations for removing hazards;
3. To work cooperatively with the hospitals; to have charge of the occupational disease clinic;
4. To carry on educational work for the prevention of occupational diseases; and
5. To cooperate in work with the United States Public Health Service, the New York department of labor, the New York department of health, the local department of health, the local medical staff, and employment departments, the local medical societies, etc.

Who shall meet the expenses of a unit of this kind? The most satisfactory plan would be to have it financed on a pro rata basis by the manufacturers of Niagara Falls. The size of the unit could be definitely fixed and the members of the organization should be selected for permanent and full-time duty. Most of the Niagara Falls plants are too small to consider the employment of a full-time physician, and, in some instances, even a nurse.

The unit outlined would provide on an economical basis the necessary medical and hygienic supervision for all employees. Because it would materially aid in improving the general health of the residents of the industrial zone, it would be legitimate for the community to pay some of the expense either out of funds allotted to the health department or by direct contributions made by such groups as the chamber of commerce and organized labor. There can be no doubt that the local community is responsible for that part of the program outlined which pertains to the maintenance of sanitary conditions in the industrial zone. Upon the community rests the responsibility for sanitary housing and for those municipal engineering projects such as water supplies, sewage disposal, and waste removal, as well as for the medical inspection and hospital care which will reduce to a minimum the losses to industry through sickness caused by conditions outside the plant. The responsibility of the community is social; that of the plant managements is not only social but economic. Employers who are meeting successfully the competition of trade are a unit in their belief that hygienic working conditions and the supervision of and care for the health of their workers are an asset,[1] in that they materially reduce accidents, sickness, absenteeism, and labor turnover, eliminating thereby costs which are a heavy burden on production. But they do more—they improve the morale of the employees and increase their efficiency. A medical organization with engineering personnel that will direct physical examinations of employees to note physical defects, analyze jobs and place workers where they are best fitted to do a full day's work, without injury to themselves, study the occupational hazards, give care to those injured or made ill by such hazards, and adopt engineering plans for their elimination, will find the monetary outlay insignificant as compared with the reduced cost in production and the increased output.

[1] Studies of the Medical and Surgical Care of Industrial Workers, by Consulting Hygienist C. D. Selby, M. D. Public Health Bulletin No. 99.